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Critical Analysis of Differentiated Learning Implementation on Science Literacy and Creativity in Elementary School Students

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ABSTRACT

This study critically analyzes the implementation of differentiated learning in improving science literacy and creativity among elementary school students. Through a qualitative literature review approach, various research findings were synthesized, demonstrating that differentiated learning, especially when combined with the Problem-Based Learning (PBL) model, significantly enhances student outcomes. The results indicate improvements in literacy, numeracy, critical thinking, and creative skills when learning is tailored to students' interests, readiness, and learning profiles. Differentiated learning not only addresses the diversity of student needs but also fosters active engagement and innovation in the classroom. The findings support the integration of differentiated strategies in science education to build foundational 21st-century competencies among young learners.

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1. INTRODUCTION

Education has an important role in shaping individuals who think critically, creatively, and have an awareness of the problems around them. In the educational philosophy of progressivism, learning must be student-centered and adapt to their needs and potential. The emphasis made by this progressivism approach is on how in the future students can face circumstances that may be different from the current era[8]. This concept is in line with the differentiated learning approach that accommodates differences in students' interests, readiness, and learning profiles[18]. Education at the primary level plays a significant role in shaping the foundation of knowledge and skills for students, in this case Science Literacy becomes a crucial element in the learning process[15].

Differentiated learning is an instructional or learning technique in which teachers use a variety of teaching methods to meet the individual needs of each student according to their needs[2]. These needs can be in the form of existing knowledge, learning styles, interests, and understanding of the subject. Differentiated learning emphasizes learning that is shaped through strengths and needs in independent learning strategies owned by learners. The presence of differentiated learning is expected to be able to accommodate the learning needs of each student who is different, as well as the learning needs of each learner.

Science literacy is the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence in order to understand and make decisions regarding nature and its changes due to human activities[17]. This statement is reinforced by[3] research which states that there are three categories of science literacy: practical science literacy, which is the application of science and technology principles to improve living

standards; cultural science literacy, which is an appreciation of science as a great achievement of mankind; and civic science literacy, which is the level of understanding required for conscious engagement in science issues relevant to today's society. The influence of differentiated learning in the aspects of science literacy and student creativity allows students to generate new ideas in solving problems.

The reality that occurs in the field shows that there are still many obstacles in the implementation of differentiated learning, especially in elementary schools. According to[6], many primary school teachers do not understand differentiated learning even though they have received socialization and training. The difficulties experienced by teachers during the implementation of differentiated learning occur systematically, it is due to the inhibiting factors of learning implementation. Teachers' readiness during planning differentiated learning and the ability of teachers who are not maximized in conducting diagnostic assessments is a factor that hinders the course of learning activities[9].

The PISA 2022 report shows that Indonesia's science literacy index score is 383, which is still low compared to other countries. In comparison, the average score for science literacy in OECD countries is 483, while Singapore has the highest score with 561 points. Indonesia's score is also below neighboring countries such as Malaysia (424) and Thailand (394) (OECD, 2022). This condition is a reflection of the less innovative pattern of science learning in Indonesia so that students' abilities tend to stagnate. Students' creativity is also not optimally developed due to the lack of learning strategies that provide space for the exploration of new ideas. In differentiated learning, teachers provide various learning options to students, so that students can learn in ways that suit their learning styles, interests and abilities[23]. These problems indicate the need to implement differentiated learning as an effort to overcome students' learning difficulties and strengthen their cognitive abilities. Based on this background, the researcher is interested in conducting a study entitled “Critical Analysis of Differentiated Learning Implementation on Science Literacy and Creativity in Elementary School Students”. With the implementation of this research, it is hoped that the application of differentiated learning can be proven effective in improving the science literacy skills and creativity of grade V students on the material of environmental problems, so as to provide an adaptive learning model to the needs of students, overcome the stagnation of science learning in elementary schools, and become a reference for teachers in developing innovative learning strategies centered on developing the individual potential of students.

2. METHODS

This research uses a type of qualitative research with a literature review approach to sources that are relevant to this research. Creswell in Meliyanti, [10] Research using a literature review approach has stages including: (1) collecting data relevant to the research study (2) researchers present the data that has been collected (3) data reduction and inventory (4) conclude based on the results of valid and reliable data verification. The data obtained from the literature review from the sources analyzed referred to using the process theory of Miles & Huberman (in Cresswell, 2014).

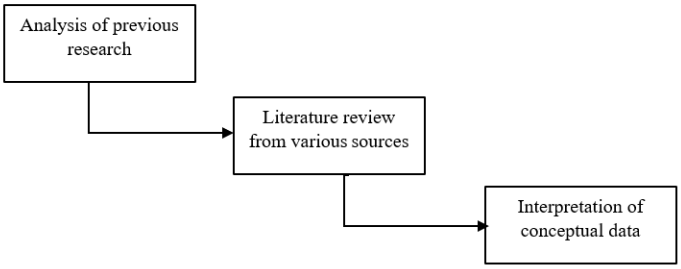

Fig. 1. Data processing and analysis

3. RESULTS AND DISCUSSION

Based on the research sources that have been collected and reviewed related to Critical Analysis of Differentiated Learning Implementation on Science Literacy and Creativity in Elementary School Students, the researcher compiled several relevant studies and can be reviewed in supporting this research. the results can be seen in the table below:

Table 1. Research relevant to Critical Analysis of Differentiated Learning Implementation on Science Literacy and Creativity in Elementary School Students

No	Title	Authors	Publication Year	Result
1	Implementation of Problem-Based Learning Model based on Differentiated Learning to Improve Science Literacy Skills and Student Activities	Virlya Citra Dewi, Nur Kuswanti, Bambang Prijono	2023	The application of Problem-Based Learning model based on differentiated learning was proven effective in improving science literacy skills and student learning activities. The results showed an increase in the N-Gain value from 0.63 in cycle I to 0.71 in cycle II, which means there was an improvement from the medium to high category. In addition, the average student activity increased from 70.32% to 88.44%.
2	Differentiated Learning Strategies to Improve Science Literacy in Elementary Schools	Septika Laily Anti, Rina Rahmi, Muhammad Nur Ikhwan	2024	This research shows that differentiated learning strategies are effective in improving elementary school students' science literacy. By customizing learning content, processes and products based on students' interests, needs and learning styles, their science literacy especially in concept understanding and critical thinking skills improved.
3	Implementation of Academic Supervision on Differentiated Learning in Public SD 07 Sungai Raya Kubu Raya District	Rohayati	2024	This study shows that the implementation of academic supervision of differentiated learning at SDN 07 Sungai Raya has gone well. Grade I and IV teachers who implement the Merdeka Curriculum show improvement in planning learning administration, preparing the flow of learning objectives (ATP), and implementing differentiated learning.

4	Effectiveness of Differentiated Learning in Improving Literacy and Numeracy of Primary School Students	Nonik Indrawatiningsih, Siti Qomariyah, Andina Rahma Nubita and Lailatul Muarofah	2023	This study proves that differentiated learning is effective in improving literacy and numeracy of primary school students. Based on statistical test results, there is a significant increase in literacy (significance value 0.04452) and numeracy (significance value 0.000938) after the implementation of differentiated learning, with an average post-test score of literacy of 73.611 and numeracy of 70.277.
5	Differentiated learning through the PBL model to improve Indonesian language learning outcomes for elementary school students	Solehudin, Siti Rochmiyati	2023	This research shows that the application of differentiated learning through the Problem-Based Learning (PBL) model has succeeded in improving student learning outcomes on main idea material in grade IV SD. After two cycles of implementation, the student learning completeness rate increased from 60% in cycle I to 85% in cycle II, indicating an increase of 25%.

3.1 Basic Concepts of Differentiated Learning in Primary School

Differentiated learning is a pedagogical approach designed to customize learning experiences based on individual learner differences[16]. In practice, teachers consider students' learning readiness, interests and learning profiles to set more personalized learning strategies. The concept aims to ensure that every student, with all their uniqueness, gets the maximum opportunity to reach their full potential. Differentiating does not mean making learning completely individualized, but rather structuring a variety of flexible learning pathways. The main principle of this approach is equity, not uniformity, so that each student is provided with support according to his or her needs[14]. At primary school level, the implementation of differentiated learning is crucial due to the diverse developmental characteristics of students[1]. With differentiation, learning becomes more adaptive and meaningful for all learners. This strategy also requires teachers to understand students deeply through continuous assessment.

The urgency of differentiated learning in primary schools is heightened given the diversity of students' academic, social and cultural backgrounds. Each learner has a different learning pace, so a uniform learning model can lead to lagging behind or boredom. With a differentiated approach, teachers can create a learning environment that is inclusive, respects differences and encourages individual growth[18]. Differentiated learning also facilitates students to feel valued and motivated in the learning process. This results in increased active participation, self-confidence, and more optimal learning outcomes. Theoretically, the application of these principles is closely related to Piaget's cognitive development theory and Vygotsky's zone of proximal development theory. Both theories emphasize the importance of paying attention to the developmental stage and learning needs of each student. Thus, learning differentiation is an important foundation in building quality basic education.

3.2 Science Literacy in Elementary School Students

Science literacy is defined as an individual's ability to understand, use and evaluate scientific information and apply science principles in everyday life. At the primary school level, the development of science literacy is an important foundation in forming a critical and rational mindset [10]. Through science literacy, students are

expected to be able to make data-based decisions, not mere assumptions. Science literacy also includes the skills of questioning, observing, interpreting data, and communicating scientific findings[12]. In the context of globalization and current technological developments, this ability is an essential need for future generations. Therefore, science learning in elementary school must be directed not only at mastering concepts, but also at developing scientific thinking competencies. Teachers need to design challenging and relevant learning experiences to improve students' science literacy. Project-based learning and simple experiments are effective strategies for this purpose[7].

However, the development of science literacy in primary school students is inseparable from various challenges that must be overcome. One of the main challenges is limited resources, such as the lack of simple laboratories and contextual teaching materials[14]. In addition, students' low interest in science lessons is another obstacle that needs serious attention. Many students consider science as a difficult and boring subject because the learning methods tend to be monotonous. Teachers are required to be more creative in packaging learning to make it fun and meaningful. Integrating science with everyday life can increase the relevance of the material and students' motivation to learn. The utilization of simple technology such as experimental videos can also help overcome facility limitations. With the right approach, the development of science literacy at the primary level can be more effective, equitable and sustainable.

3.3 Primary School-Age Children's Creativity in Learning

Creativity in primary school children is an innate potential that needs to be developed through appropriate stimulation. In general, creativity can be defined as the ability to generate new, original and useful ideas in various contexts[5]. At primary school age, children are in the concrete-operational phase of cognitive development according to Piaget, so they begin to be able to think logically as well as imaginatively[17]. In learning, creativity can come in many forms, such as producing artwork, finding alternative solutions, or making simple experiments. Teachers play an important role in creating a safe and supportive expression space for children's creativity. A learning environment that is open, challenging and respectful of different ideas is key in developing creativity[4]. In addition, providing open-ended and project-based tasks can also stimulate students' creative thinking. Creativity honed from an early age will be an important asset to face future challenges.

Factors that influence children's creativity include the family environment, learning methods, social interactions, and the personal characteristics of the students themselves. A supportive and non-judgmental environment will encourage children to dare to innovate. Conversely, an environment that demands too much uniformity tends to kill students' creative potential. In the context of classroom learning, a variety of teaching strategies such as Problem-Based Learning or Project-Based Learning are very effective in fostering creativity[20]. Teachers also need to provide opportunities for students to take intellectual risks without fear of making mistakes. Thus, learning becomes a process of active exploration, not just passive acceptance of information. Creativity developed through basic education will equip students with innovative thinking skills that are much needed in the 21st century. Therefore, creativity development should be prioritized in learning planning and implementation.

3.4 The Relationship Between Differentiated Learning, Science Literacy and Creativity

Differentiated learning is theoretically and practically closely related to the development of students' science literacy and creativity[13]. By customizing learning strategies based on students' individual needs, differentiation allows each child to access science materials in a way that works best for him or her. In this context, students who get the right approach will more easily understand scientific concepts in depth. This understanding becomes the basis for a solid and sustainable strengthening of science literacy. In addition, when students are given choices in the learning process and products, their creativity is encouraged to develop[22]. They learn to think critically, explore ideas and come up with creative solutions to problems. Thus, differentiated learning is not only oriented towards academic achievement, but also builds innovative competencies.

The support of Jean Piaget's constructivism theory and Howard Gardner's multiple intelligences theory strengthens the relationship between differentiation, science literacy and creativity[23]. Constructivism emphasizes the importance of learner-centered active learning, while multiple intelligences theory highlights the diversity of individual intellectual potential. Thus, differentiated learning allows students to develop science literacy through meaningful and relevant experiences. Meanwhile, the space to create and choose in the learning process becomes fertile ground for the growth of creativity. When science literacy and creativity go hand in hand, students are not only recipients of knowledge, but also creators of innovation. The integration of these three aspects is an important foundation for shaping the profile of smart, critical and creative 21st century learners[21]. Therefore, differentiated learning must continue to be pursued consistently in basic education practices.

3.5 Strategies for Implementing Differentiated Learning in Elementary School Science Classrooms

Implementing differentiated learning in elementary school science classes requires careful planning and a deep understanding of student characteristics[16]. The main strategy in its implementation is to adjust the content, process and product of learning. Content can be customized through presenting materials with different

levels of complexity based on students' readiness. The learning process can be differentiated through a variety of activities such as small group discussions, practical experiments or independent exploration[11]. Learning products can also vary from written reports, scientific posters, to creative presentations. Thus, each student can demonstrate their understanding in a way that best suits their individual strengths. Teachers need to use formative assessment to understand students' needs and development on an ongoing basis. This assessment becomes the basis for determining the most appropriate form of differentiation. Teacher flexibility and creativity are key to the successful implementation of this strategy.

A concrete example of this strategy is the implementation of interest-based science projects, where students choose research topics according to their interests[19]. In this project, students can conduct simple experiments at home or at school and then report the results in a format of their choosing. In addition, the use of interactive learning media such as virtual simulations or experimental videos also enriches the differentiated learning process. Problem-based learning and inquiry-based learning are effective approaches to accommodate students' different learning styles[22]. In each stage, teachers need to provide appropriate scaffolding to keep all students motivated and challenged. With the right strategy, science learning in elementary school not only improves students' science literacy, but also develops their creativity and self-confidence. Ultimately, implementing differentiation will create a dynamic, inclusive and productive science classroom.

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